

CLAIMS:

1. A method for making and screening a combinatorial library comprising:

disposing in a substrate comprising boron, boron nitride, or boron carbide at least one reactant, wherein the reactants are lithium, magnesium, sodium, potassium, calcium, aluminum or a combination comprising at least one of the foregoing reactants;

heat treating the substrate to create a diffusion multiple having at least two phases;

contacting the diffusion multiple with hydrogen;

detecting any absorption of hydrogen; and/or

detecting any desorption of hydrogen.

2. The method of Claim 1, wherein the lithium, magnesium, sodium, potassium, calcium, and aluminum are disposed in at least one hole in the substrate.

3. The method of Claim 1, wherein the heat treatment is conducted at a temperature of about 600 to about 1,000°C when the substrate is boron; a temperature of about 650 to about 1,250°C when the substrate is boron carbide; or a temperature of about 660 to about 1250°C when the substrate is boron nitride.

4. The method of Claim 1, wherein at least one reactant is disposed in the substrate and forms a binary couple upon heat treatment.

5. The method of Claim 1, wherein at least one reactant is disposed in the substrate and forms a ternary triple upon heat treatment.

6. The method of Claim 1, wherein at least two reactants are disposed in the substrate and forms a ternary triple upon heat treatment.

7. The method of Claim 1, further comprising identifying and analyzing at least one phase of the diffusion couple using electron microprobe analysis.
8. The method of Claim 1, further comprising slicing and grinding the diffusion multiple.
9. The method of Claim 8, further comprising analyzing the diffusion multiple by electron microprobe analysis or electron backscatter diffraction.
10. The method of Claim 8, wherein the slicing and grinding of the diffusion multiple is conducted after the heat treatment.
11. The method of Claim 1, wherein the determining the absorption of hydrogen is by time of flight secondary mass ion spectrometry, thermal imaging or by using a tungsten oxide detector.
12. A method of recovering hydrogen comprising:  
  
contacting at least one compound selected from the group consisting of  $\text{AlB}_2$ ,  $\text{AlB}_{12}$ ,  $\text{B}_6\text{Ca}$ ,  $\text{B}_6\text{K}$ ,  $\text{B}_{12}\text{Li}$ ,  $\text{B}_6\text{Li}$ ,  $\text{B}_4\text{Li}$ ,  $\text{B}_3\text{Li}$ ,  $\text{B}_2\text{Li}$ ,  $\text{BLi}$ ,  $\text{B}_6\text{Li}_7$ ,  $\text{BLi}_3$ ,  $\text{MgB}_2$ ,  $\text{MgB}_4$ ,  $\text{MgB}_7$ ,  $\text{NaB}_6$ ,  $\text{NaB}_{15}$ ,  $\text{NaB}_{16}$  or a combination comprising at least one of the foregoing borides with hydrogen to form a hydrogenated compound; and  
  
heating the hydrogenated compound to recover the hydrogen.
13. The method of Claim 12, wherein the heating is conducted using microwave radiation, convectional heating, electrical resistive heating, or a combination comprising at least one of the foregoing methods of heating.
14. The method of Claim 12, further adding a dopant comprising titanium, vanadium zirconium, yttrium, lanthanum, nickel, manganese, cobalt, boron, gallium, germanium, and the elements from the lanthanide series to the compound in an amount of less than or equal to about 20 wt% of the diffusion multiple.
15. The method of Claim 12, wherein the heating is effected by the heat from the exhaust of a fuel cell.

16. An energy generation device, wherein the method of Claim 12 is employed to generate energy.

17. A method of recovering hydrogen comprising:

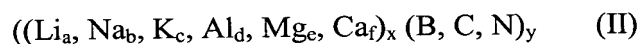
contacting at least one compound of a diffusion multiple, wherein the diffusion multiple has the formula (II)



where Li is lithium, Na is sodium, Mg is magnesium, K is potassium, Ca is calcium, Al is aluminum; B is boron, C is carbon and N is nitrogen; a, b, c, d, e and f may be the same or different and have values from 0 to 1; and x and y have values of about 1 to about 22; in hydrogen to form a hydrogenated compound; and

heating the hydrogenated compound to recover the hydrogen.

18. A diffusion multiple comprising compounds having the formula (II)



where Li is lithium, Na is sodium, Mg is magnesium, K is potassium, Ca is calcium, Al is aluminum; B is boron, C is carbon and N is nitrogen; a, b, c, d, e and f may be the same or different and have values from 0 to 1; and x and y have values of about 1 to about 22.

19. The compounds of Claim 18, wherein the sum of a, b, c, d, e, and f is equal to 1.

20. A composition comprising:

a hydride of a compound, wherein the compound is  $\text{AlB}_2$ ,  $\text{AlB}_{12}$ ,  $\text{B}_6\text{Ca}$ ,  $\text{B}_6\text{K}$ ,  $\text{B}_{12}\text{Li}$ ,  $\text{B}_6\text{Li}$ ,  $\text{B}_4\text{Li}$ ,  $\text{B}_3\text{Li}$ ,  $\text{B}_2\text{Li}$ ,  $\text{BLi}$ ,  $\text{B}_6\text{Li}_7$ ,  $\text{BLi}_3$ ,  $\text{MgB}_2$ ,  $\text{MgB}_4$ ,  $\text{MgB}_7$ ,  $\text{NaB}_6$ ,  $\text{NaB}_{15}$ ,  $\text{NaB}_{16}$  or a combination comprising at least one of compounds.

21. A system for the storage and recovery of hydrogen comprising:

a hydrogen generation reactor in fluid communication with a hydride recycle reactor, wherein the hydrogen generation reactor utilizes hydrides of light metal borides, borocarbides and boronitrides to recover hydrogen.

22. The system of Claim 21, wherein the hydrogen generation reactor is in fluid communication with and down stream of a slurry production reactor.

23. The system of Claim 21, wherein the hydrogen generation reactor is in fluid communication with and up stream of a drying and separation reactor.

24. The system of Claim 22, wherein the slurry production reactor is in fluid communication with and downstream of a drying and separation reactor.

25. The system of Claim 21, wherein the hydride recycle reactor is in fluid communication with a slurry production reactor.

26. The system of Claim 21, wherein a metal hydride slurry is transferred to the hydrogen generation reactor from a slurry production reactor.

27. The system of Claim 21, wherein a regenerated metal hydride is transferred from the hydride recycle reactor to a slurry production reactor.

28. The system of Claim 21, wherein water is introduced into the hydrogen generation reactor.

29. The system of Claim 21, wherein hydrogen is generated in the hydrogen generation reactor by the use of heat from microwave radiation, convective heat, exhaust heat from a fuel cell.